Risk-based Decision-making Guidelines

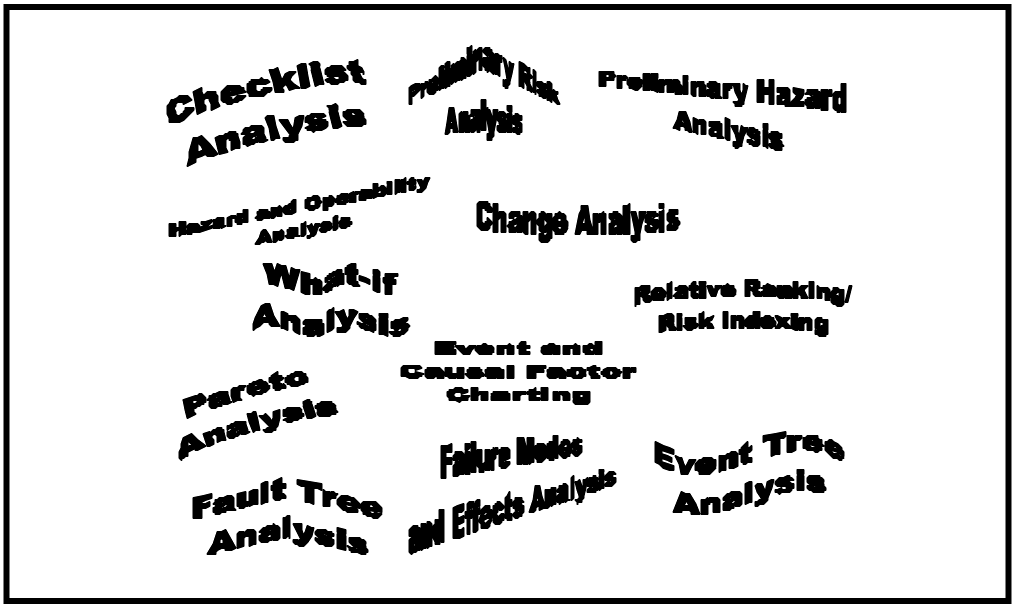
Volume 3
Procedures for Assessing Risks

Getting Started with Risk Assessments

Chapter 1 — Selecting an Appropriate Risk Assessment Approach

Chapter Contents

This chapter provides information for choosing an appropriate risk assessment approach and is referenced by Volume 1, *Risk-based Decision-making Navigator*



Choosing a Risk Assessment Method

There are many different risk assessment methods and tools. These *Guidelines* discuss a number that are highly useful for assessing marine systems. Choosing the right method for the situation is, of course, key to any successful risk assessment. To select an appropriate risk assessment tool, several factors must be considered. This chapter describes the factors that strongly affect this choice and suggests risk assessment approaches to support different types of decision making within the Coast Guard.

Key Factors in Choosing Risk Assessment Methods

- **Reason for risk assessment**
- **Type of results needed**
- **Type of resources available**
- **Complexity and size of the risk assessment**
- **Type of activity or system**
- **Type of incidents targeted**

Key Factors in Choosing Risk Assessment Methods

The following sections discuss several key factors in choosing risk assessment methods.

Reason for a risk assessment

The reason behind a risk assessment should be of utmost importance to every analyst. A risk assessment performed without an understanding of the reasoning behind it and without a well-defined purpose will waste time and money. Many issues can shape the purpose of an assessment. For example:

- What is the reason for the risk assessment in the first place?
- Is the risk assessment being performed because of a policy for new marine activities?
- Is an understanding of risk needed in order to make decisions for improving an existing onboard system (e.g., propulsion, steering)?
- Does the risk assessment meet a regulatory, legal, or stakeholder requirement?

Individuals responsible for choosing the best technique and putting together the necessary human, technical, and physical resources must be given a well-defined purpose so they can skillfully meet the risk assessment objectives.

Type of results needed

The *type* of results needed is an important factor in choosing a risk assessment technique. Depending on the reason for the risk assessment, many types of results may be needed to meet the study's objective. Following are five categories of information that can be produced from most risk assessments:

- Possible problems
- Ways in which these problems occur (i.e., failure modes, causes, sequence)
- Ways to reduce the frequency of these problems
- Areas needing further analysis or input for a quantitative risk analysis
- Ranking of results

Most of the risk assessment techniques provide lists of how problems occur and possible options for reducing risk; these options are known as action items.

Type of resources available

Two important conditions define the information available to a risk assessment team: (1) the current phase of life for the activity or system and (2) the quality and timeliness of the documentation.

The first condition is usually fixed for any risk assessment. The stage of life limits the amount of information available to the risk assessment team. For example, if a risk assessment is to be performed on a *proposed* marine activity, it is unlikely that an organization will already have detailed descriptions of the activity, written procedures, or design drawings. Therefore, if the analyst must choose between hazard and operability (HAZOP) analysis and what-if analysis, this *phase-of-life* factor would call for a less detailed analysis technique, such as what-if.

The second condition deals with the quality and timeliness of existing documentation. For a risk assessment looking at an *existing* activity or system, analysts may find that the design drawings are not up to date or do not exist in a suitable form. Using out-of-date information is not only futile, it is a waste of time and resources. Therefore, if all other factors point to a technique that must have such information, the analysts should request that the information be updated before performing the risk assessment.

Complexity and size of the risk assessment

Some techniques get bogged down when they are used to analyze very complicated problems. The complexity and size of a problem are based on the number of activities or systems, the number of pieces of equipment, the number of operating steps, and the number and types of events and effects being analyzed. For most risk assessment techniques, a larger number of equipment items or operating steps will increase the time and effort needed to perform a study. For example, the failure modes and effects analysis (FMEA) technique will generally take five times more effort for a system containing 100 equipment items than for a system containing 20 items. Therefore, the effort required to perform a risk assessment is proportional to the types and number of events and effects being evaluated.

Type of activity or system

Many techniques can be used for almost any marine activity or system. However, some techniques are better for some systems than for others. For example, the FMEA approach is one of the best for analyzing electronic control systems, while HAZOP analysis often does not work as well for those types of systems.

The choice of techniques can also be affected by the type of operation. Consider the following questions related to operation type:

(1) Is it a fixed facility (e.g., a shoreside refinery, a storage facility) or a transportation system (e.g., a transiting vessel)?

(2) Is it permanent, transient (e.g., a one-time operation), or temporary?

(3) Is it continuous or sporadic?

Whether an activity is permanent or not affects the choice of technique in the following way: If all other factors are equal, analysts may use a more detailed approach if they know the process will continue operating for a long time. A more detailed and better documented risk assessment of a permanent operation could be used to support other needed activities, such as safety programs or employee training programs. On the other hand, analysts may choose a less detailed technique if the subject activity is a *one-time* operation. For instance, an analyst may use the checklist technique to evaluate a one-time maintenance activity rather than using a more complicated approach.

Type of accidents targeted

Organizations usually use more thorough techniques for those systems they believe involve significant risk and for situations in which failures are expected to have severe consequences. This approach increases the chances that possible problems will be uncovered.

Suggested Risk Assessment Approaches for Different Types of Decision Making

The rest of this chapter suggests ways to perform risk assessments as part of maritime decision-making processes. The following pages divide maritime decision making into several major sections, provides examples of relevant decision-making situations, identifies the risk information needed for different types of decisions, and suggests risk assessment approaches for providing that information. The advice on choosing a risk assessment approach is very situation-specific; it anticipates the most common field applications. The advice also offers both streamlined and more detailed approaches in addition to recommending a suggested approach for each situation.

To find the most appropriate advice in the following pages, you will be using three sets of information:

(1) **A high-level listing of field unit decision-making applications (page 1-11)**. Once you find the most relevant application for you, the listing will point you to a summary of recommended risk assessment tools for that application.

(2) **A summary of recommended risk assessment tools for various field decision-making applications (pages 1-12 to 1-26)**. For your applications, you will find a table with a more detailed listing of specific decision-making scenarios. For the scenario that is most comparable to your situation, you will find advice on which risk assessment tools are most valuable. The table will point you to a more detailed discussion of your situation and ways to best use the recommended risk assessment tools.

(3) **A detailed discussion of the risk-based decision-making process and recommended risk assessment approaches for common marine safety applications (pages 1-27 to 1-68).** You will find a description of how the risk-based decision-making process might occur for your situation. The focus is on specific situations you will likely encounter in the field and how the constraints and needs associated with these situations suggest appropriate risk assessment approaches. A suggested approach is provided for each situation and is generally based on lessons learned from previous field applications at units. In addition, more streamlined and more detailed risk assessment approaches are provided in case the suggested approach does not fit your situation. At the end of each discussion, a table summarizes the approximate level of effort you should expect for each of the suggested risk assessment approaches. This table should facilitate planning for risk assessment, but it will probably also help you choose among the possible approaches.

If you do not find a situation comparable to your own in this section, contact G-MSE for advice. If you want to continue selecting a risk assessment approach on your own, you should read at least the following *Guidelines* chapters for advice:

Volume 2, Chapter 1, “Principles of Risk-based Decision Making”

Volume 2, Chapter 6, “Risk Assessment Tools”

If you have found an approach that seems to meet your needs, you should turn to Volume 3, Chapter 2, “Managing a Risk Assessment Project,” to help you get started. Of course, you will also want to study the procedures in Volume 3 for applying the specific tools you have chosen. Example risk assessments and other resources from Volume 4 will also be helpful.

Field Unit Decision-making Applications

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

What actions should be taken to address port and waterway operations posing the greatest risk to safety and environmental protection? (see page 1-12)

What actions will minimize risk for specific operations or systems of special concern? (see pages 1-13 and 1-14)

How can the risk of upcoming changes in port and waterway operations best be managed? (see page 1-15)

Does a proposed alternative compliance strategy provide the same level of protection as the established requirements? (see page 1-16)

How should the CG plan monitoring and surveillance activities to minimize risk? (see page 1-17)

Conducting Inspections

Which types of inspections should a unit emphasize to minimize risk? (see page 1-18)

What should a unit inspect? How should CG resources best be allocated among various vessels and facilities? (see page 1-19)

Which evaluation points should a unit emphasize during an inspection? (see page 1-20)

What actions should be taken in response to a recognized deficiency? (see page 1-21)

2.0 Preparedness-related Decisions

What accidents or locations should a unit emphasize in response planning? (see page 1-23)

What strategies will minimize the risk associated with a specific accident scenario? (see page 1-24)

3.0 Response-related Decisions

What investigative actions should be taken to prevent recurrence of accidents? (see page 1-25)

What actions should be taken to minimize operational risks during response actions? (see page 1-26)

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.1 What actions should be taken to address port and waterway operations posing the greatest risk to safety and environmental protection?

Example applications:

- Performing a port-wide risk assessment
- Establishing priorities for business planning
- Focusing harbor safety committee discussions

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Simple prioritization of issues	Relative ranking/risk indexing	Pareto analysis	Preliminary risk analysis	See pages 1-27 and 1-28
More sophisticated risk profiles	Preliminary risk analysis	Preliminary risk analysis (less detail)	Preliminary risk analysis (more detail)	See pages 1-27 and 1-29

1.2 What actions will minimize risk for specific operations or systems of special concern?

Example applications:

- Response to harbor safety committee initiatives
- Response to industry initiatives
- Response to accident or near-miss trends
- Response to complaints
- Due diligence reviews of new operations or systems
- Formulation of COTP Orders
- Vessel traffic management decisions

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Risk assessment of marine casualties (such as vessel collisions, allisions, groundings, and fires)	Event tree analysis Checklist analysis	What-if analysis Relative ranking/risk indexing	Supplementary fault tree analyses	See pages 1-30 and 1-31
Casualty response capability/dependability assessment	Event tree analysis Checklist analysis	What-if analysis Relative ranking/risk indexing	Supplementary fault tree analyses	See pages 1-30 and 1-33
Mechanical or electrical system analysis	Failure modes and effects analysis Checklist analysis	What-if analysis	Fault tree analysis	See pages 1-30 and 1-35
Fluid or thermal system analysis	Hazard and operability analysis Checklist analysis	What-if analysis	Fault tree analysis	See pages 1-30 and 1-36
Risk assessment of one type of loss in complex systems of any type	Fault tree analysis Checklist analysis	What-if analysis	None suggested	See pages 1-30 and 1-37

Table (cont.)

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Risk assessment of human mistakes during critical work tasks	Hazard and operability analysis (as applied to procedures) Error-likely situation and human factors checklists	What-if analysis	Event tree analysis (as applied for human reliability analyses)	See pages 1-30 and 1-38
Risk assessment of new operations or systems early in development, definition, or design	What-if analysis Checklist analysis	None suggested	Preliminary hazard analysis	See pages 1-30 and 1-40

1.3 How can the risk of upcoming changes in port and waterway operations best be managed?

Example applications:

- Regattas and parades
- Firework displays
- Festivals (e.g., OPSAIL 2000)
- Marine construction
- New facilities and operations in a port (e.g. a new marina)

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Routine marine events and marine construction	Checklist analysis Relative ranking/risk indexing	Operational risk management	See "Unique marine events and marine construction" in the next row of this table	See pages 1-41 and 1-42
Unique marine events and marine construction	Change analysis	Checklist analysis	What-if analysis Preliminary risk analysis	See pages 1-41 and 1-43
Changes in waterway usage	Change analysis Preliminary risk analysis	Checklist analysis	See "What actions will minimize risk for specific operations or systems of special concern" on page 1-13	See pages 1-41 and 1-44

1.4 Does a proposed alternative compliance strategy provide the same level of protection as the established requirements?

Example applications:

- Allowing reduced lifesaving requirements, compared to new regulatory requirements, for vessels with an effective alternative compliance strategy
- Determining equivalent levels of safety for navigation safety equipment deviations

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Decisions for many operators in similar situations	Relative ranking/risk indexing	Checklist analysis	Various other tools to support relative ranking/ risk indexing	See pages 1-45 and 1-46
Decision for individual operators in unique situations	Change analysis	Checklist analysis	See "What actions will minimize risk for specific operations or systems of special concern" on page 1-13	See pages 1-45 and 1-47

1.5 How should the CG plan monitoring and surveillance activities to minimize risk?

Example applications:

- Routine harbor patrols
- Routine facility inspections
- Routine boardings

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Operational risk management Checklist analysis	None suggested	Pareto analysis What-if analysis	See page 1-48

Conducting Inspections

1.6 Which types of inspections should a unit emphasize to minimize risk?

Example applications:

- Business planning for inspection activities
  - Vessel inspections (foreign and domestic)
  - Facility inspections
  - Container inspections
  - Cargo transfer monitoring
  - Explosives handling supervision
  - Uninspected vessel boardings
- Regulation improvement initiatives

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Simple prioritization of inspections	Relative ranking/risk indexing	Pareto analysis	Preliminary risk analysis	See pages 1-50 and 1-51
More sophisticated risk profiles	Preliminary risk analysis	Preliminary risk analysis (less detail)	Preliminary risk analysis (more detail)	See pages 1-50 and 1-52

1.7 What should a unit inspect? How should CG resources best be allocated among various vessels and facilities?

Example applications:

- Port State Control Targeting
- Facility inspections
- Vessel boardings and inspections

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Relative ranking/risk indexing	Pareto analysis	None suggested	See page 1-53

1.8 Which evaluation points should a unit emphasize during an inspection?

Example applications:

- Determining inspection items for a Port State Control boarding
- Facility inspections
- Vessel boardings and inspections

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Checklist analysis Relative ranking/risk indexing	Pareto analysis	Failure modes and effects analysis	See pages 1-54 and 1-55

1.9 What actions should be taken in response to a recognized deficiency?

Example applications:

- Determining a deficiency priority during a Port State Control boarding
- Facility inspections
- Vessel boardings and inspections

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Relative ranking/risk indexing	Operational risk management	None suggested	See page 1-56

2.0 Preparedness-related Decisions

2.1 What accidents or locations should a unit emphasize in response planning?

Example applications:

- Area contingency plans
- Area committee focus items
- Facility response plans
- Vessel response plans

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Simple prioritization of issues	Relative ranking/risk indexing	Pareto analysis	Preliminary risk analysis	See pages 1-57 and 1-58
More sophisticated risk profiles	Preliminary risk analysis	Preliminary risk analysis (less detail)	Preliminary risk analysis (more detail)	See pages 1-57 and 1-59

2.2 What strategies will minimize the risk associated with a specific accident scenario?

Example applications:

- Deciding what cleanup technologies to use in response to an oil spill
- Deciding how to handle a barge or vessel with structural damage from a collision, allision, or grounding accident

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Relative ranking/risk indexing	Operational risk management Checklist analysis	What-if analysis	See page 1-60

3.0 Response-related Decisions

3.1 What investigative actions should be taken to prevent recurrence of accidents?

Example applications:

- Marine casualty investigations
- Facility oil spills and other hazardous material releases
- Investigations of occupational injury or illness on vessels

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
Single serious event (or near miss): Complex sequence of events	Event and causal factor charting Checklist analysis (using the Root Cause Map)	None suggested	Supplementary change analysis	See pages 1-63 and 1-64
Single serious event (or near miss): Straightforward sequence of events	Fault tree analysis Checklist analysis (using the Root Cause Map)	None suggested	Supplementary change analysis	See pages 1-63 and 1-65
Single, less serious event	Simple fault tree analysis (i.e., 5 Whys analysis) Checklist analysis (using the Root Cause Map)	5 Whys analysis alone	Supplementary change analysis	See pages 1-63 and 1-66
Series of repeated, similar incidents (chronic problems)	Fault tree analysis Checklist analysis (using the Root Cause Map)	None suggested	Supplementary change analysis	See pages 1-63 and 1-67

3.2 What actions should be taken to minimize operational risks during response actions?

Example applications:

- Response to marine casualties
- Response to oil and HAZMAT spills
- ICS-based responses

Common Application Categories	Analysis Options			Application Advice
	Suggested	Streamlined	Advanced	
All situations	Operational risk management Checklist analysis	None suggested	Pareto analysis What-if analysis	See page 1-68

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.1 What actions should be taken to address port and waterway operations posing the greatest risk to safety and environmental protection?

Example applications:

- Performing a port-wide risk assessment
- Establishing priorities for business planning
- Focusing harbor safety committee discussions

It is important to understand the risk profile of a port or waterway in order to establish risk management priorities and to meet performance goals. An overall risk profiling effort generally develops the following:

- A relative comparison of risks associated with various port and waterway operations
- An estimate of the actual level of risk (i.e., expected losses) associated with various port and waterway operations. This “absolute risk” information is not always needed.
- Suggested actions for managing the most significant risks, including various prevention, monitoring, and response tasks by the Coast Guard and other stakeholders
- An estimate of the risk reduction benefits of suggested actions in relation to their implementation costs (i.e., benefit-cost)

Units typically approach risk profiling from one of the following perspectives:

- Developing a simple prioritization of issues to focus efforts and attention (see page 1-28)
- Developing a more sophisticated risk profile to (1) quantify expected losses from various port and waterway operations and (2) balance marine safety program activities according to risks (see page 1-29)

Developing a simple prioritization of issues to focus efforts

The AOR for each unit includes a unique mix of port and waterway operations, combined with unique geological, environmental, and cultural conditions. The differences among AORs create different risk management priorities for each unit. Often, the staff at a unit needs only a simple relative comparison of the risks of various operations in the AOR. This will help the staff focus its efforts on the areas of greatest concern. In this case, the unit's staff typically does not need highly refined risk assessments or especially precise results.

Suggested analysis approach

- Develop a simple hierarchy of port and waterway operations and apply a relative ranking/risk indexing approach to the elements of the hierarchy (see Chapter 5, "Relative Ranking/Risk Indexing")

Streamlined alternatives

- Develop Pareto analyses of historical losses associated with each element of a simple hierarchy of port and waterway operations. Keep in mind that the Pareto analyses will account only for past losses and may not be the best predictors of future losses (see Chapter 3, "Pareto Analysis").

More detailed alternative

- See the following section, "Developing a more sophisticated risk profile"

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 2 days	NA	NA
Small	<1 week	1 to 3 days	NA
Large	2 to 4 weeks	<1 week	NA

Developing a more sophisticated risk profile

A relative ranking of port and waterway operations according to perceived risk will help many units initially, but most will eventually want more information. More sophisticated risk profiles help the unit's staff (1) predict the numbers and types of accidents expected, (2) assess the acceptability of the risks, (3) describe the key contributors to various types of accidents, and (4) assess the benefit of implementing risk controls. The quantitative risk profile provides a basis for defending resource allocation decisions and answers questions such as, "How much of our budget should we spend on prevention activities for this port operation?" and "If we reduce our investments in these prevention activities, will the risk increase significantly?"

MSOs in this situation typically are trying to create a baseline measurement tool to guide their decision making. In this case, they are willing to invest significant resources, probably a few weeks of staff time, to gain that information.

Suggested analysis approach

- Develop a simple hierarchy of port and waterway operations and apply the preliminary risk analysis approach to the elements of the hierarchy (see Chapter 6, "Preliminary Risk Analysis")

Streamlined alternatives

- Use a less detailed hierarchy or broader frequency and consequence ranges for risk scoring in the analysis

More detailed alternative

- Use a more detailed hierarchy or narrower frequency and consequence ranges for risk scoring in the analysis
- More detailed risk assessment using other tools may be warranted for either of the following situations:
  (1) The risk of a certain type of loss is highly uncertain, but it could cause a substantial consequence
  (2) The risk is known to be significant, but the unit needs a more detailed understanding of how a loss could occur and how it could be prevented

(See the guidance in this chapter of the *Guidelines* under the topic "Managing Port and Waterway Operations: What actions will minimize the risk for operations or systems of special concern?" to identify an appropriate analysis tool.)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	<1 week	1 to 2 days	1 to 2 weeks
Large	2 to 6 weeks	<1 week	6 to 12 weeks

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.2 What actions will minimize risk for specific operations or systems of special concern?

Example applications:

- Response to harbor safety committee initiatives
- Response to industry initiatives
- Response to accident or near-miss trends
- Due diligence reviews of new operations or systems
- Formulation of COTP Orders
- Vessel traffic management decisions

For any number of reasons, a unit may target a specific port operation or system for risk reduction. The unit generally needs the following information in order to develop an effective risk reduction strategy:

- A description of the key combinations of equipment failures, human errors, and external events (i.e., scenarios) capable of causing losses of interest
- A qualitative (and possibly quantitative) ranking of scenarios according to risk. Quantification is not always necessary.
- Suggested actions for managing the most significant risks, including various prevention, monitoring, and response tasks by the Coast Guard and other stakeholders
- An understanding of the benefits of suggested risk management actions in relation to their implementation costs (i.e., benefit-cost)

A unit typically finds that its application will fit into one of the following categories:

- Assessing the risk of vessel collisions, allisions, groundings, and fires (see page 1-31)
- Assessing the risk associated with casualty response capability or dependability (see page 1-33)
- Assessing the risk of failures in mechanical or electrical systems (see page 1-35)
- Assessing the risk of failures in fluid or thermal systems (see page 1-36)
- Assessing the risk of one type of loss (e.g., loss of vessel propulsion) in complex systems of any type (see page 1-37)
- Assessing the risk of human mistakes during critical work tasks, including the risk of occupational injuries or illnesses (see pages 1-38)
- Assessing the risk of new operations or systems early in development, definition, or design (see page 1-40)

Assessing the risk of vessel collisions, allision, groundings, and fires

Example applications:

- Assessing the risk of high-speed craft collisions with other vessels
- Assessing the risk of fires in engine rooms
- Assessing the risk of barges running aground in a particular waterway

Vessel collisions, allisions, groundings, and fires typically result from chains of events that involve any one of several initiating events along with the failure of several barriers, or safeguards. Assessing the risk of these losses requires an understanding of how the many possible chains of events might unfold and how likely each chain is. With this information in hand, the unit can prioritize the many possible accident scenarios and identify effective ways to block the progression of the most likely ones. The analysis must include equipment failures, human errors, and external conditions, and it must be able to model dependencies among these events. A qualitative understanding of the accident scenarios is sometimes enough to identify improvement opportunities, but some level of quantification is usually needed, especially for defending the benefit-cost of expensive risk-reduction actions.

Suggested analysis approach

- Perform event tree analyses to identify the accident scenarios that can cause the losses of concern and to estimate the likelihood of such occurrences (see Chapter 12, "Event Tree Analysis")
- Apply any applicable checklists that may exist (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- Perform a what-if analysis to identify key accident scenarios of concern to knowledgeable subject matter experts. A quantitative analysis of these scenarios can be performed if necessary, but it may have significant uncertainty or imprecision (see Chapter 8, "What-if Analysis").
- Relative ranking/risk indexing can be used in place of detailed risk calculations to rate the risk associated with various scenarios (see Chapter 5, "Relative Ranking/Risk Indexing")

More detailed alternative

- Use fault tree analyses to model the key contributors to (1) the initiating events included in the event trees and (2) vulnerabilities in each barrier (i.e., line of assurance) addressed in the event trees. This level of detail can be very time consuming and expensive. It should be reserved only for the most complicated, serious, or high-profile applications.

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day (checklist)	1 day (relative ranking/risk indexing)	NA
Small	1 to 2 weeks	1 to 3 days	2 to 4 weeks
Large	3 to 4 weeks	<1 week	4 to 12 weeks

Assessing the risk associated with casualty response capability or dependability

Example applications:

- Assessing the need for additional lifesaving capacity on vessels operated far from rescue and response assets
- Assessing the impact of reduced lifesaving requirements for vessels operating with special restrictions or features

For casualty response and lifesaving applications, the Coast Guard generally ensures that a dependable response capability will be in place regardless of how likely the initiating events are to occur. For example, even if a vessel sinking is extremely unlikely, the Coast Guard would generally still require a certain level of lifesaving capacity onboard the vessel. Risk assessment in these situations assumes that an initiating event will occur and focuses on improving the probabilities of successful rescue and recovery. A qualitative understanding of the accident scenarios is sometimes enough to identify improvement opportunities, but some level of quantification is usually needed, especially for defending the benefit-cost of expensive risk reduction actions.

Suggested analysis approach

- Perform event tree analyses both to identify the accident scenarios that can cause the loss of concern and to estimate the likelihood of such occurrences, assuming that the initiating event will occur (see Chapter 12, "Event Tree Analysis")
- Apply any applicable checklists that may exist (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- Perform a what-if analysis to identify key accident scenarios of concern to knowledgeable subject matter experts. A quantitative analysis of these scenarios can be performed if necessary, but it may have significant uncertainty or imprecision (see Chapter 8, "What-if Analysis").
- Relative ranking/risk indexing can be used in place of detailed risk calculations to prioritize the risk associated with various scenarios (see Chapter 5, "Relative Ranking/ Risk Indexing")

More detailed alternative

- Use fault tree analyses to model the key elements contributing to vulnerabilities in each line of assurance addressed in the event trees. This level of detail can be very time consuming and expensive, and it should be reserved only for the most complicated, serious, or high-profile applications (see Chapter 11, "Fault Tree Analysis," for predictive applications).

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day (checklist)	1 day (relative ranking/risk indexing)	NA
Small	1 to 2 weeks	1 to 3 days	2 to 4 weeks
Large	3 to 4 weeks	<1 week	4 to 12 weeks

Assessing the risk of failure in mechanical or electrical systems

Example applications:

- Assessing the risk of individual propulsion, steering, lifting, etc., system failures
- Assessing the risk of electrical power generation and distribution system failures
- Assessing the risk of communication system failures

A unit may be interested in detailed analysis of a specific mechanical or electrical system under the following conditions:

(1) Such a system has been identified previously (e.g., in a broader risk profiling analysis) as a significant risk contributor, and a more detailed understanding of its vulnerabilities is needed to identify effective risk reduction actions

(2) There is significant uncertainty about how much risk such a system poses, and a more detailed analysis is needed to improve risk understanding

(3) New or modified systems are being introduced, and their failure could result in a serious loss

The risk of mechanical and electrical system failures is often dominated by individual equipment failure modes because any one component failure often causes a malfunction of the entire system. The key for most of these analyses is a systematic examination of the system to find important failure modes.

Suggested analysis approach

- Perform a failure modes and effects analysis of the system, including some form of failure mode criticality ranking to identify and prioritize critical failure modes and to develop risk reduction recommendations (see Chapter 9, "Failure Modes and Effects Analysis")
- Apply any applicable checklists that may exist (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- Perform a less rigorous what-if analysis to identify key failures of concern to knowledgeable subject matter experts (see Chapter 8, "What-if Analysis")

More detailed alternative

- Use fault tree analyses to model key failures where redundant components or complex safeguards are in place to help prevent or mitigate component failures (see Chapter 11, "Fault Tree Analysis," for predictive applications)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day (checklist)	NA	NA
Small	<1 week	1 to 3 days	2 to 4 weeks
Large	2 to 4 weeks	<1 week	4 to 8 weeks

Assessing the risk of failure in fluid or thermal systems

Example applications:

- Assessing the risk of transfers of oil or chemicals at marine terminals
- Assessing the risk of sewage, bilge, ballast, etc., pumping operations aboard a ship

A unit may be interested in a detailed analysis of a specific fluid or thermal system under the following conditions:

(1) Such a system has been identified previously (e.g., in a broader risk profiling analysis) as a significant risk contributor, and a more detailed understanding of its vulnerabilities is needed to identify effective risk reduction actions

(2) There is significant uncertainty about how much risk such a system poses, and a more detailed analysis is needed to improve risk understanding

(3) New or modified systems are being introduced, and their failure could result in a serious loss

The risk of fluid and thermal system failures is often dominated by individual events (both human errors and equipment failures) that cause malfunctions of the system. These malfunctions, or deviations from the design intention, have the potential to cause losses of concern. The key for most of these analyses is a systematic understanding of how these deviations can occur, what losses are possible, and what protective features need to be in place.

Suggested analysis approach

- Perform a hazard and operability (HAZOP) analysis of the system to identify and prioritize critical failure modes and to develop risk reduction recommendations (see Chapter 10, "Hazard and Operability Analysis")
- Apply any applicable checklists that may exist (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- Perform a less rigorous what-if analysis to identify key failures of concern to knowledgeable subject matter experts (see Chapter 8, "What-if Analysis")

More detailed alternative

- Use fault tree analyses to model key failures where redundant components or complex safeguards are in place to help prevent or mitigate component failures (see Chapter 11, "Fault Tree Analysis," for predictive applications)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day (checklist)	NA	NA
Small	<1 week	1 to 3 days	2 to 4 weeks
Large	2 to 4 weeks	<1 week	4 to 8 weeks

Assessing the risk of one type of loss in complex systems of any type

Example application:

- Assessing the risk of failures in complex, redundant sensor systems

A unit may be interested in detailed analysis of a complex system under the following conditions:

(1) Such a system has been identified previously (e.g., in a broader risk profiling analysis) as a significant risk contributor, and a more detailed understanding of its vulnerabilities is needed to identify effective risk reduction actions

(2) There is significant uncertainty about how much risk such a system poses, and a more detailed analysis is needed to improve risk understanding

(3) New or modified systems are being introduced, and their failure could result in a serious loss

The risk of failure in complex systems often involves many combinations of equipment failures, human errors, and external events, especially if redundancy is built into the system. The key for most of these analyses is to systematically identify the combinations of events that can produce the loss of interest and prioritize the many possible combinations. Common cause failures that defeat planned redundancy are also of particular interest during such analyses.

Suggested analysis approach

- Perform a fault tree analysis of the losses of interest to identify the most significant contributors to risk and to develop risk reduction recommendations (see Chapter 11, “Fault Tree Analysis,” for predictive applications)
- Apply any applicable checklists that may exist (see Chapter 4, “Checklist Analysis”)

Streamlined alternatives

- Perform a less rigorous what-if analysis to identify key failures of concern to knowledgeable subject matter experts (see Chapter 8, “What-if Analysis”)

More detailed alternative

- None suggested

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	2 to 4 weeks	1 to 3 days	NA
Large	4 to 8 weeks	<1 week	NA

Assessing the risk of human mistakes during critical work tasks

Example applications:

- Assessing the risk of injuries while performing processing operations aboard fishing vessels
- Assessing the risk of injuries while performing drills aboard ships
- Assessing the risk of helm mistakes while transiting a vessel

A unit may be interested in detailed analysis of a critical work task under the following conditions:

(1) Such a task has been identified previously (e.g., in a broader risk profiling analysis) as a significant risk contributor, and a more detailed understanding of possible error-likely situations is needed to identify effective risk reduction actions

(2) There is significant uncertainty about how much risk such a task poses, and a more detailed analysis is needed to improve risk understanding

(3) New or modified tasks are being introduced, and mistakes could result in a serious loss

The risk of a critical work task is often dominated by single mistakes by individuals. These mistakes can be the result of individual performance problems, but they are more often caused by error-likely situations that set individuals up to make mistakes. The key for most of these analyses is a systematic understanding of how these mistakes can be made and how error-likely situations and workplace hazards can be minimized.

Suggested analysis approach

- Perform a guide word analysis of the procedure, either written or unwritten, for the critical work task. This allows the analyst to identify possible mistakes and to develop risk reduction recommendations (see Chapter 10, "Hazard and Operability Analysis," as applied to procedures).
- Use error-likely situation checklists to identify ways to eliminate common situations that lead to human mistakes (see Chapter 4, "Checklist Analysis," as applied to error-likely situations and human factors considerations)

Streamlined alternatives

- Perform a less rigorous what-if analysis to identify key mistakes of concern to knowledgeable subject matter experts (see Chapter 8, "What-if Analysis")

More detailed alternative

- Use human reliability event trees to model ways in which losses requiring multiple mistakes, and possibly some equipment failures, can occur (see Chapter 12, "Event Tree Analysis," as applied for human reliability analyses)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 3 days (checklist)	NA	NA
Small	1 to 3 days	~1 day	1 to 2 weeks
Large	2 to 4 weeks	<1 week	3 to 6 weeks

Assessing the risk of new operations or systems early in development, definition, or design

Example applications:

- Assessing risk of a new excursion operation under development for a port or waterway
- Assessing risk of a new vessel design that may enter the port or waterway

Few details may be available early in the development, definition, or design of a new operation or system. On the surface, it may appear too soon to do a risk assessment. In reality, this may be one of the most beneficial times to perform at least a simple risk assessment whose results may significantly affect the direction taken by the project. When major new initiatives are under way, the unit may want a risk assessment to help preempt later delays and conflicts over risk concerns. Any such analysis at this point must be performed with minimal resources and at a fairly high level, with limited detail.

Suggested analysis approach

- Perform a what-if analysis to identify issues of concern to knowledgeable subject matter experts (see Chapter 8, "What-if Analysis")
- Apply any applicable checklists (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- None suggested

More detailed alternative

- Perform a preliminary hazard analysis to identify key areas of risk and ways in which this risk will be managed as the project matures (see Chapter 14, "Preliminary Hazard Analysis")

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day (checklist)	NA	NA
Small	~ 1 day	NA	1 to 2 days
Large	2 to 3 days	NA	< 1 week

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.3 How can the risk of upcoming changes in port and waterway operations best be managed?

Example applications:

- Regattas, races, and parades
- Firework displays
- Festivals (e.g., OPSAIL 2000)
- Marine construction
- New facilities and operations in a port (e.g., a new marina)

Significant risks can be introduced by special events, temporary disruptions in routine operation, and new facilities or operations in a port or waterway. To effectively manage the risks of such situations, a unit generally needs the following:

- A clear list of the ways in which the change situation is different from previous conditions and operations
- An assessment of the risk impact of the changes
- Suggested actions for managing the most significant risks. These may include various prevention, monitoring, and response tasks by the Coast Guard and other stakeholders.
- An understanding of the benefits of suggested risk management actions in relation to their implementation costs (i.e., benefit-cost)

The change situations normally faced by a unit should fall into one of the following categories:

- Review and approval of temporary changes
  - Routine marine events and marine construction (see page 1-42)
  - Unique marine events and marine construction (see page 1-43)
- Review and approval of more permanent changes in waterway usage (see page 1-44)

Review and approval of marine events and marine construction: Routine

Most units see many requests for marine events and marine construction. Although each request has some unique characteristics, the majority pose similar risk concerns, and the Port Operations Divisions at MSOs handle these requests in a fairly routine manner. In these cases, the unit needs to ensure that the unique characteristics of each request receive appropriate attention, but it cannot afford to invest significant resources in detailed, individual analyses for each request. The COTP needs to know the risk level perceived by the Port Operations Division, but it is often comfortable with a qualitative statement of risk (e.g., "high") or a more basic risk index score.

Suggested analysis approach

- Develop risk analysis checklists for different types of marine events and marine construction (see Chapter 4, "Checklist Analysis")
- Include in the checklists a relative ranking/risk indexing approach for (1) characterizing the overall risk associated with the temporary activities and (2) prioritizing significant risk factors for resolution (see Chapter 5, "Relative Ranking/Risk Indexing")
- Provide the applicable checklists to applicants for self-assessment, including development of their proposed risk management strategies for significant risk factors
- Review and improve submitted requests, including any self-assessment provided by the requestor. Determine (1) whether the COTP should allow the activities and (2) appropriate risk management actions the COTP should require.

Streamlined alternatives

- Save initial development time, and a little implementation time, by omitting the relative ranking/risk indexing method. With this approach, any overall characterization of risk for the COTP would be completely subjective and qualitative.
- Save initial development time by applying tactical operational risk management (ORM) principles to each review instead of developing a structured risk analysis checklist tool. This approach would probably be less effective in the long term and might even be more resource intensive (see COMDINST 3500.3 on Operational Risk Management).

More detailed alternative

- Treat the routine requests as unique requests, as discussed on the following page. This approach will provide more detailed analyses but will require more analysis resources and will be somewhat redundant across applications.

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 2 days	~1 day	NA
Small	1 to 2 hours	1 to 2 hours	See table on next page
Large	4 to 8 hours	4 to 8 hours	See table on next page

Review and approval of marine events and marine construction: Unique

In addition to routine requests, units on occasion see requests for less common marine events and marine construction. These requests pose special risk concerns, and the Port Operations Divisions at units handle these requests on a case-by-case basis. In these cases, the unit needs to ensure that the unique characteristics of each request receive appropriate attention, and the unit will generally invest significant resources in more detailed, individual analyses for each request. The COTP needs to know how much risk is perceived by the Port Operations Division, but it is often comfortable with a qualitative statement of risk (e.g., "high") or perhaps a more systematic basic risk index score. However, in some cases (e.g., unprecedented events), an even more refined risk characterization may be desired.

Suggested analysis approach

- Apply change analysis in order to (1) distinguish potentially important risk contributors from routine port and waterway operations and (2) develop a risk management strategy involving all stakeholders as appropriate in prevention, monitoring, and response actions (see Chapter 7, "Change Analysis")

Streamlined alternatives

- In place of change analysis, simply apply any checklists that have already been developed for routine marine events or marine construction. This approach will require fewer resources but will likely overlook some potentially important issues not incorporated into the checklists (see Chapter 4, "Checklist Analysis").

More detailed alternative

- Conduct a high-level preliminary risk analysis, covering only the major accidents of interest for the duration of the marine event, to characterize the risk profile of the marine event or marine construction activity (see Chapter 6, "Preliminary Risk Analysis")
- As a complement to the change analysis, perform a what-if analysis to explore key areas of concern in more detail. This approach can be particularly effective for planning response actions to credible scenarios (see Chapter 8, "What-if Analysis").

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	NA	<1 day	NA
Small	1 to 2 days	1 to 2 hours	< 1 week
Large	2 to 4 days	2 to 4 hours	1 to 2 weeks

Review and approval of changes in waterway usage

Units also receive various types of request for changes in waterway usage. Examples include new marinas or terminals, new types of marine activity in the waterway, changes in navigation routes, etc. These requests may pose special risk concerns, and the Port Operations Divisions at units handle these requests on a case-by-case basis. To manage such proposed changes effectively, the unit needs to ensure that the unique characteristics of each request receive appropriate attention, and the unit will generally invest significant resources in more detailed, individual analyses for each request. The COTP needs to know the level of risk perceived by the Port Operations Division, but it is often comfortable with a qualitative statement of risk (e.g., "high") or perhaps a more systematic basic risk index score. However, in some cases (e.g., unprecedented events), an even more refined risk characterization is often desired.

Suggested analysis approach

- Apply change analysis in order to (1) distinguish potentially important risk contributors from current port and waterway operations and (2) develop a risk management strategy involving all stakeholders (see Chapter 7, "Change Analysis")
- Either update any existing port-wide risk analysis to account for the changes in risk associated with the changes in waterway usage, or conduct a high-level preliminary risk analysis covering only the major accidents of interest to characterize the risk profile of the revised waterway usage (see Chapter 6, "Preliminary Risk Analysis")

Streamlined alternatives

- In place of change analysis, simply apply any waterway management checklists that have been developed. This approach will require fewer resources but will likely overlook some potentially important issues not incorporated into the checklists (see Chapter 4, "Checklist Analysis").

More detailed alternative

- As a complement to the change analysis, try to identify specific steps for reducing the risk associated with the new or revised waterway usage. (See the guidance in this chapter of the *Guidelines* under the topic "Managing Port and Waterway Operations: What actions will minimize the risk for specific operations or systems of special concern?" to identify an appropriate analysis tool.)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	NA	<1 day	NA
Small	1 to 2 days	1 to 2 hours	NA
Large	2 to 4 days	2 to 4 hours	NA

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.4 Does a proposed alternative compliance strategy provide the same level of protection as the established requirements?

Example application:

- Allowing lifesaving requirements less stringent than new regulatory requirements for vessels with an effective alternative compliance strategy
- Determining equivalent levels of safety for navigation safety equipment deviations

Regulations and policies establish requirements that vessel and facility operators must follow. However, a COTP or OCMI often has some flexibility, through waivers or alternative compliance strategies, in applying requirements to specific situations. In these situations, a unit can often work with operators to define cost-effective alternatives to the established regulatory requirements that provide the same risk or less. To approve an alternative compliance strategy, a COTP or OCMI generally needs the following information:

- A listing of how the proposed alternative compliance strategy differs from the established requirements
- A listing of the most risk-significant differences between the two cases
- An overall assessment of whether the risk associated with the alternative compliance strategy is comparable to the risk associated with the compliance requirements

Allowing an operator to deviate from established requirements can be a difficult decision for a COTP/OCMI. By approving an alternative compliance strategy, the COTP/OCMI is typically accepting greater responsibility than it would by simply mandating operator compliance. In addition, alternative compliance strategies are very vulnerable to second-guessing if an accident ever occurs, even if the statistical risks were less than those expected with basic regulatory compliance.

Decisions to approve alternative compliance strategies are driven somewhat by personality; some officers will be less willing to grant approvals than others. Although each officer's risk tolerance may vary, the basic nature of this decision-making process requires more than just subjective choices. It requires technically defensible results that can be explained to all of the stakeholders in the process.

A unit typically encounters two types of situations involving requests for alternative compliance:

- Review and approval of alternative compliance strategies for many operators in similar situations (see page 1-46)
- Review and approval of alternative compliance strategies for individual operators in unique situations (see page 1-47)

Review and approval of alternative compliance strategies for many operators in similar situations

Changes in regulatory requirements and enforcement strategies generally apply to many vessels and facilities within a unit's AOR. It is not uncommon for many operators facing increased requirements to seek relief under alternative compliance strategies. If permitted by regulations, the COTP/OCMI can entertain such requests, but they need to be sure that the decision-making process is (1) technically defensible to all stakeholders and (2) consistent among operators. The process also must not consume too many resources, because it may be repeated many times among operators in the AOR.

Suggested analysis approach

- Develop a relative ranking/risk indexing tool that (1) highlights the factors important to the approval decision and (2) provides an overall risk-based rating of the alternative compliance strategy against the compliance case. A risk scoring index based on plus/minus scores compared to the compliance case may be particularly effective for this application (see Chapter 5, "Relative Ranking/Risk Indexing").

Streamlined alternatives

- Rather than developing a relative ranking/risk indexing tool, a simple checklist of pass/fail criteria could be developed and employed more quickly, and possibly with less subjectivity (see Chapter 4, "Checklist Analysis")

More detailed alternative

- A more detailed risk assessment of key issues of concern could be performed while developing the relative ranking/risk indexing tool to help improve the quality of the tool. (This approach is described in Chapter 5, "Relative Ranking/Risk Indexing.")
- An even more detailed approach would be to develop a complete risk model (e.g., using a fault tree analysis) for the baseline, compliance situation. The model could then be reassessed for each alternative compliance case by adjusting the failure model or failure data. This approach can be very resource intensive and should not be used until simpler options have been exhausted.

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 3 days	1 day	1 to 3 days (relative ranking/risk indexing)
Small	1 to 3 days	~1 day	~1 week
Large	~1 week	1 to 2 days	2 to 4 weeks

Review and approval of alternative compliance strategies for individual operators in unique situations

Some vessel or facility operators find themselves in unique regulatory situations that they believe deserve special consideration. This may include a vessel operator who is covered under a regulation not intended for his or her type of vessel or operation, or a vessel operator who is using advanced technology that minimizes the importance of a regulatory requirement. If permitted either by regulations or by the broader authority associated with command of a unit, a COTP/OCMI can entertain such requests. However, the COTP/OCMI needs to be sure that the decision-making process is technically defensible to all stakeholders. These situations deserve special, individualized attention from the unit's staff.

Suggested analysis approach

- Apply change analysis to (1) identify potentially important risk contributors when compared to the baseline, compliance case and (2) develop a risk management strategy involving all stakeholders (see Chapter 7, "Change Analysis")

Streamlined alternatives

- In place of change analysis, simply apply any checklists that have been developed. This approach will require fewer resources, but it will likely overlook some potentially important issues not incorporated into the checklists

More detailed alternative

- As a complement to the change analysis, try to identify specific actions to reduce the risk associated with the new or revised waterway usage. (See the guidance in this section of the *Guidelines* under the topic "Managing Port and Waterway Operations: What actions will minimize the risk for specific operations or systems of special concern?" to identify an appropriate analysis tool.)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	1 to 2 days	~1 day	2 to 4 days
Large	<1 week	1 to 3 days	1 to 2 weeks

1.0 Prevention-related Decisions

Managing Port and Waterway Operations

1.5 How should the CG plan monitoring and surveillance activities to minimize risk?

Example applications:

- Routine harbor patrols
- Routine facility inspections
- Routine boardings

Operational assets, such as MSO field inspectors and Group assets supporting "M" missions, encounter dynamic situations in which the following risk information is needed:

- An understanding of key risk factors affecting the operation
- An overall assessment of whether the risk is too high to continue
- An understanding of the factors and conditions that must be monitored as the operation continues to ensure that changing risk conditions are identified early

Individual operations occur at a fast tempo, and there is seldom time to perform formal, detailed analyses during operations. However, several factors can significantly increase the potential for accidents during operations. These include the following:

- Complacency during operations
- Failure to account for differences between routine operations and less common operations
- Changing conditions (e.g., weather, threats, crew fatigue, etc.)

The crew or staff needs a simple tool to help it (1) stay aware of risks in operations and (2) communicate risks among the crew. Of course, there may be time between operations to examine high-risk operations and seek ways to reduce the associated risks.

Suggested analysis approach

- Apply tactical operational risk management (ORM) concepts to help manage these operational risks (*see* COMDTINST 3500.3 on ORM for details)
- Use checklists as job aids to help improve crew or staff awareness of key risk factors during these operations (*see* Chapter 4, "Checklist Analysis")

Streamlined alternatives

- None suggested

More detailed alternative

- Perform a Pareto analysis of past accidents and ensure that effective risk reduction actions have been taken to keep accidents from recurring (*see* Chapter 3, "Pareto Analysis")

- If concerns about a particular type of operation exist, or there is simply a desire to reduce risk associated with these operations, perform a what-if analysis to (1) describe the risks of greatest concern to knowledgeable subject matter experts and (2) develop a list of risk reduction recommendations (see Chapter 8, “What-if Analysis”)

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	<1 day	NA	NA
Small	Minutes	NA	~1 day
Large	<1 hour	NA	1 to 3 days

1.0 Prevention-related Decisions

Conducting Inspections

1.6 Which types of inspections should a unit emphasize to minimize risk?

Example applications:

- Business planning for inspection activities
  - vessel inspections (foreign and domestic)
  - facility inspections
  - container inspections
  - cargo transfer monitoring
  - explosive handling supervision
  - uninspected vessel boardings
  - etc.
- Regulation improvement initiatives

The Coast Guard has the authority and responsibility to conduct many types of inspections. Within a unit's AOR, many types of inspections occur regularly for vessels and shore facilities. Generally, the COTP/OCMI has considerable flexibility, within legal requirements, in determining which types of inspections will occur most frequently and in the most detail. A key question for a COTP/OCMI is, "How should the unit allocate resources across various types of inspections to minimize risk?" To make this decision, the COTP/OCMI typically needs the following information:

- A relative risk comparison of various port and waterway operations subject to inspection
- An estimate of the actual level of risk (i.e., expected losses) associated with various port and waterway operations subject to inspection. This "absolute risk" information is not always needed.
- A map showing which types of inspections are intended to influence which types of risk
- An estimate of the current investment in various types of inspections
- A listing of (1) inspections that could be reduced with minimal impact on associated risks and (2) inspections that should be increased to provide significant risk reduction

The COTP typically faces this question in the following situations:

- Developing a simple prioritization of inspections to focus efforts and attention (see page 1-51)
- Developing a more sophisticated risk profile to balance the unit's inspection resources according to risk (see page 1-52)

Developing a simple prioritization of inspections to focus efforts and attention

The AOR for each unit includes a unique mix of port and waterway operations combined with unique geological, environmental, and cultural conditions. The uniqueness of each AOR creates different risk management priorities for each unit. Often, the staff at a unit simply needs a quick relative comparison of the risk impacts of various inspections to help it focus its efforts on the areas of greatest opportunity. In this case, the unit's staff typically does not need highly refined analyses, or especially precise results, and wants to invest minimal time and effort in creating this relative risk prioritization.

Suggested analysis approach

- Develop a listing of inspections of interest, and apply the relative ranking/risk indexing approach to establish inspection priorities (see Chapter 5, "Relative Ranking/Risk Indexing")

Streamlined alternatives

- Develop (1) a Pareto analysis that shows for each type of inspection the number of accidents within the AOR that could have been prevented through inspection enhancements and (2) a Pareto analysis that shows for each type of inspection the number of "good catches" that probably prevented accidents. Of course, the Pareto analyses will account only for past accidents and may not be the best predictors of future accidents (see Chapter 3, "Pareto Analysis").

More detailed alternative

- See the following section, "Developing a more sophisticated risk profile"

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 day	NA	NA
Small	1 to 2 days	1 to 2 days	NA
Large	1 to 2 weeks	~1 week	NA

Developing a more sophisticated risk profile

A relative ranking of inspection types according to perceived risk impact will help many units initially, but most units will eventually want more information. More sophisticated risk profiles provide a basis for defending resource allocation decisions and help answer questions such as, "How much of our budget should we spend on each type of inspection activity?" and "If we reduce our investments in these types of inspections, will the risk increase significantly?"

Units in this situation typically are trying to create a baseline measurement tool to guide their decision making, and they are willing to invest significant resources (several weeks of staff time) to gain that information.

Suggested analysis approach

- Develop a hierarchy of port and waterway operations of interest, and apply the preliminary risk analysis approach to elements of the hierarchy (see Chapter 6, "Preliminary Risk Analysis")
- Identify the types of inspection that can influence each type of risk represented in the profile, and estimate the level of resources currently allocated to each type of inspection. Perhaps this can be done through activity-based costing.
- Judge how sensitive the risk profile would be to changes in resources allocated to each type of inspection. That is, how much would the risk profile change for both increasing and decreasing inspection resources.

Streamlined alternatives

- Use a less detailed hierarchy or broader frequency and consequence ranges for risk scoring in the analysis

More detailed alternative

- Use a more detailed hierarchy or narrower frequency and consequence ranges for risk scoring in the analysis

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	<1 week	1 to 2 days	1 to 2 weeks
Large	2 to 6 weeks	<1 week	6 to 12 weeks

1.0 Prevention-related Decisions

Conducting Inspections

1.7 What should a unit inspect? How should CG resources best be allocated among various vessels and facilities?

Example applications:

- Port State Control Targeting
- Facility inspections
- Vessel boardings and inspections

For any type of inspection, the COTP/OCMI often has considerable flexibility in determining which assets will be inspected and how often. Performance-based inspection suggests that good performers should be inspected less frequently or in less detail than poor performers. A key question is, "How should the unit allocate resources to specific assets?" To make this decision, the unit typically needs a relative risk comparison for various assets subject to a particular type of inspection. The risk comparison is usually not between two different vessels; rather, it compares each vessel to a standard scoring process with criteria established for inspection requirements. Such scoring schemes must be applied quickly, requiring from a few minutes up to an hour or two. The results must be technically defensible, but they do not have to be highly precise in most cases.

Suggested analysis approach

- Develop a relative ranking/risk indexing tool for scoring individual assets to determine inspection priority. The results should indicate whether an inspection should be conducted and in what level of detail (see Chapter 5, "Relative Ranking/Risk Indexing").

Streamlined alternatives

- Develop a Pareto analysis of the asset's past performance relative to the subject inspection to determine whether an inspection should be conducted and in what level of detail (see Chapter 3, "Pareto Analysis")

More detailed alternative

- None suggested

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	~ 1 week	NA	NA
Small	<1 hour	1 to 4 hours	NA
Large	NA	NA	NA

1.0 Prevention-related Decisions

Conducting Inspections

1.8 Which evaluation points should a unit emphasize during an inspection?

Example applications:

- Determining inspection items for a Port State Control boarding
- Facility inspections
- Vessel boardings and inspections

Under a performance-based inspection strategy, the key for any inspection is to ensure that the most important evaluation points receive the most attention. For this to occur, the list of evaluation points must include checks of all risk-significant items, and any particular inspection must emphasize the most risk-significant evaluation points. In judging risk significance, the decision maker needs to consider both of the following:

(1) Do the types of deficiency targeted by an evaluation point contribute significantly to overall risk? This is a measure of risk contribution.

(2) Does an evaluation point perform an effective check of a critical safeguard whose failure would cause a significant increase in risk? This is a measure of risk sensitivity.

The inspection staff typically needs the following to determine what evaluation points should be emphasized during an inspection:

- A complete list of applicable and effective evaluation points that verify the status of planned safeguards within the scope of a particular type of inspection
- A prioritized list of these evaluation points indicating which ones are the most risk significant (i.e., have the largest risk contribution or a high risk sensitivity)

Fortunately, unit inspection staffs have many types of inspection books and other checklists outlining important evaluation points for various types of inspection. The keys are to (1) be sure the list of evaluation points is reasonably complete and (2) apply a risk significance weighting to the evaluation points for specific inspection plans, such as the inspection plan for a specific type of vessel. The results must be technically defensible, but they do not have to be highly precise in most cases.

Suggested analysis approach

- Use the evaluation points in existing inspection booklets/checklists as the basis for an inspection, adding any missing evaluation points that experience has proven important (see Chapter 4, "Checklist Analysis")
- Develop a relative ranking/risk indexing tool to score the risk significance of evaluation points for each type of inspection application. For example, consider having different priorities for different types of vessels or shore facilities (see Chapter 5, "Relative Ranking/Risk Indexing").

Streamlined alternative

- Instead of using a relative ranking/risk indexing tool, develop a Pareto analysis of a type of asset's past performance and use this to determine subjectively what evaluation points to emphasize (see Chapter 3, "Pareto Analysis")

More detailed alternative

- Perform a function-based failure modes and effects analysis to systematically (1) ensure that appropriate evaluation points are defined for important safeguards against functional failures and (2) assess the risk contribution and sensitivity of each of the defined evaluation points. This process is resource intensive. It works better applied to a narrow scope of critical concern than broadly across an entire vessel or shore facility. This process is comparable to a reliability-centered maintenance (RCM) approach. (See Chapter 9, "Failure Modes and Effects Analysis.")

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 2 days	NA	NA
Small	1 to 2 days	~1 day	2 to 4 days
Large	2 to 4 days	1 to 2 days	2 to 4 weeks

1.0 Prevention-related Decisions

Conducting Inspections

1.9 What actions should be taken in response to a recognized deficiency?

Example applications:

- Determining a deficiency priority during a Port State Control boarding
- Facility inspections
- Vessel boardings and inspections

Deficiencies resulting from inspections should be prioritized based on their risk impact. The inspection staff needs a quick way to assess the risk impact of a deficiency so that it can assign an appropriate priority to the deficiency. Subjective judgments by inspectors can be variable and sometimes argumentative. A more systematic process, which could be unique for each type of inspection, could make deficiency priorities more technically defensible.

Suggested analysis approach

- Develop a relative ranking/risk indexing tool to score deficiencies. This tool could be generic for any type of deficiency, or the scoring for each evaluation point could be built directly into the inspection booklet or checklist (see Chapter 5, "Relative Ranking/Risk Indexing")

Streamlined alternatives

- Apply tactical operational risk management (ORM) concepts to incorporate risk-based information into the current subjective prioritization process for most inspections (see COMDTINST 3500.3 on ORM for details)

More detailed alternative

- None suggested

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 2 days	NA	NA
Small	Minutes	Minutes	NA
Large	~ 1 hour	~ 1 hour	NA

2.0 Preparedness-related Decisions

2.1 What accidents or locations should a unit emphasize in response planning?

Example applications:

- Area contingency plans
- Area committee focus items
- Facility response plans
- Vessel response plans

Response plans are important risk mitigation features for many types of marine casualty and environmental accidents. The range and location of possible events is so broad that a unit's staff must focus on the highest-risk situations first when developing contingency plans. To prioritize response planning efforts, the unit generally needs an overall risk profile for accidents of interest to the planning team, including the following:

- A relative risk comparison of various events and locations in a port or waterway
- An estimate of the actual level of risk (i.e., expected losses) associated with various events and locations. This "absolute risk" information is not always needed.
- A list of key issues that need to be addressed in response plans for various types of events and locations

A unit typically approaches prioritization of accidents and locations for response planning from one of two perspectives:

- Developing a simple prioritization of accidents and locations to focus efforts (see page 1-58)
- Developing a more sophisticated risk profile to (1) quantify expected losses from various accidents and locations and (2) balance USCG response planning resources according to risks (see page 1-59)

Developing a simple prioritization of accidents or locations to focus efforts and attention

The AOR for each unit includes a unique mix of port and waterway operations combined with unique geological, environmental, and cultural conditions. The uniqueness of each AOR creates different response planning priorities for each unit. Often, the staff at a unit simply needs a quick relative comparison of the risks of various accidents or locations in the AOR to help it focus its planning efforts and attention on the areas of greatest concern. In this case, the unit's staff typically does not need highly refined analyses (or especially precise results) and wants to invest minimal time and effort in creating this relative risk prioritization.

Suggested analysis approach

- Develop a hierarchy of port and waterway operations of interest, and apply the relative ranking/risk indexing approach to the elements of the hierarchy (see Chapter 5, "Relative Ranking/Risk Indexing")

Streamlined alternatives

- Develop Pareto analyses for various types of accidents grouped by locations. Of course, the Pareto analyses will account only for past accidents and may not be the best predictors of future accidents (see Chapter 3, "Pareto Analysis").

More detailed alternative

- See the following section, "Developing a more sophisticated risk profile"

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	1 to 2 days	NA	NA
Small	1 to 2 days	1 to 2 days	NA
Large	1 to 2 weeks	~1 week	NA

Developing a more sophisticated risk profile

A relative ranking of accidents and locations for response planning according to perceived risk will help many units initially, but most units will eventually want more information. More sophisticated risk profiles help the staff (1) predict the numbers and types of accidents expected, (2) assess the acceptability of the risks of certain operations, (3) describe the key contributors to various types of accidents, and (4) assess the benefit of implementing various types of risk management controls. The quantitative nature of a more sophisticated risk profile provides a basis for answering resource allocation questions such as, "How much of our budget should we spend on response planning for specific accidents and locations?" and "If we reduce our investments in preparedness for certain accidents and locations, will the risk increase significantly?"

Units in this situation typically are trying to create a baseline measurement tool to guide their decision making and are willing to invest significant resources (several weeks of staff time) to gain that information.

Suggested analysis approach

- Develop a hierarchy of port and waterway operations of interest, and apply the preliminary risk analysis approach to the elements of the hierarchy (see Chapter 6 on Preliminary Risk Analysis)

Streamlined alternatives

- Use a less detailed hierarchy or broader frequency and consequence ranges for risk scoring in the analysis

More detailed alternative

- Use a more detailed hierarchy or narrower frequency and consequence ranges for risk scoring in the analysis

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	<1 week	1 to 2 days	1 to 2 weeks
Large	2 to 6 weeks	<1 week	6 to 12 weeks

2.0 Preparedness-related Decisions

2.2 What strategies will minimize the risk associated with a specific accident scenario?

Example applications:

- Deciding what cleanup technologies to use in response to an oil spill
- Deciding how to handle a barge or vessel with structural damage from a collision, allision, or grounding accident
- Deciding what resource modifications are necessary to reduce risks of specific types of accidents

Selection of a specific response strategy for a marine casualty or environmental accident is often a choice from among several alternatives. The response team typically needs the following information to choose an appropriate response strategy:

- A relative risk comparison of various response strategies
- A list of key risk control issues that need to be addressed as the strategy is implemented

In most cases, these decisions have to be made quickly, so there is little time for detailed risk assessment. Simple risk characterizations are generally acceptable, but the results must be technically defensible.

Suggested analysis approach

- Develop a list of typical response strategies for different types of response situations. Apply a relative ranking/risk indexing approach to rate these strategies, as well as strategy options developed in the field, for a specific application (see Chapter 5, "Relative Ranking/Risk Indexing")

Streamlined alternatives

- Apply tactical operational risk management (ORM) concepts to help the response team incorporate risk-based information into its response strategy decision (see COMDTINST 3500.3 on ORM for details)
- Use checklists as job aids to help ensure the appropriateness of specific response strategies for intended applications (see Chapter 4, "Checklist Analysis")

More detailed alternative

- If a more detailed analysis of risks involving possible response strategies is needed for a specific application, perform a what-if analysis to identify key areas of risk and appropriate risk controls (see Chapter 8, "What-if Analysis")

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	2 to 4 weeks	~1 week	NA
Small	1 to 4 hours	~ 1 hour	4 to 8 hours
Large	4 to 8 hours	1 to 4 hours	1 to 2 days

3.0 Response-related Decisions

3.1 What investigative actions should be taken to prevent recurrence of accidents?

Example applications:

- Marine casualty investigations
- Facility oil spills or other hazardous material releases
- Occupational injury or illness investigations on vessels

Investigating accidents to prevent recurrence is an important and often high-profile activity at a unit. During an investigation, the goal is to develop the following information:

- A qualitative description of the sequence of events that led to either one specific accident or a series of repeated, similar accidents. This sequence of events may include a combination of equipment failures, human errors, and external conditions.
- A listing of the key causal factors contributing to the accidents, taken from the accident sequences
- A qualitative description of the underlying root causes of each causal factor
- At least one recommendation for correcting each of the underlying root causes for each causal factor

A unit is likely to launch an investigation for any one of the following situations:

- A single, serious accident or near miss, such as a specific marine casualty, involving:
  - A complex sequence of events, often involving a variety of equipment failures, human mistakes, and external effects (see page 1-64)
  - A relatively straightforward sequence of events (see page 1-65)
- A less serious, single accident or near miss such as a minor property loss event or oil spill (see page 1-66)
- A series of repeated, similar incidents such as an increase in the number of a specific type of vessel deficiency over the past year (see page 1-67)

Investigation of a single serious accident or near miss deserving detailed investigation: Complex sequence of events

Whenever a serious accident or near miss occurs, a marine safety investigator conducts an investigation of the accident. Although marine safety inspectors are very busy, serious accidents and near misses draw a lot of attention, and a thorough investigation is expected. In this situation, detailed findings that are technically defensible are critical, even if the Coast Guard has to pull resources from other areas to support the investigation. This can be quite challenging when complex sequences of events involve vessel interactions, weather or sea conditions, traffic control instructions, various types of response actions, etc. Guiding the effective collection of data from various sources and integrating the data into a model that describes the accident sequence requires a systematic process, especially when time dependencies among various events are critical to understanding the loss.

Suggested analysis approach

- Use event and causal factor charting to discover and describe the sequence of events leading to the accident. Then identify the key causal factors contributing to the accident (see Chapter 13, "Event and Causal Factor Charting").
- Use a knowledge-based tool such as a root cause map to systematically explore the underlying root causes of each casual factor (see the description of the Root Cause Map in Chapter 4, "Checklist Analysis," and see the full version of the map that is included in your copy of the *Guidelines*).

Streamlined alternative

- A streamlined approach is not recommended

More detailed alternative

- Use change analysis during the investigation to help identify subtle differences between the conditions and events associated with the accident and those associated with other, problem-free operations. This can be particularly effective when the investigation team has trouble defining even the basic elements of the accident sequence (see Chapter 7, "Change Analysis").

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	<1 week	NA	Suggested approach + ~ 2 to 8 hours
Large	1 to 4 weeks	NA	

Investigation of a single serious accident or near miss deserving detailed investigation: Relatively straightforward sequence of events

Some serious accidents and near misses result from less complex chains of events. In fact, the apparent chain of events is sometimes only one or two events long; for example, a rudder failure occurs, causing the craft to strike the rocks. Of course, there are still a number of underlying reasons why the rudder failed, and these underlying reasons need to be examined. In these cases, the investigation often focuses on only one or two equipment failures or human errors, but examines them in some detail.

Suggested analysis approach

- Use fault tree analysis during the investigation to discover why the critical equipment failures or human errors occurred. Then identify the key causal factors that must be resolved to prevent recurrence of the accident (see Chapter 11, “Fault Tree Analysis,” as applied to investigations of individual accidents).
- Use a knowledge-based tool such as a root cause map to systematically explore the underlying root causes of each casual factor (see the description of the Root Cause Map in Chapter 4, “Checklist Analysis,” and see the full version of the map that is included in your copy of the *Guidelines*).

Streamlined alternative

- A streamlined approach is not recommended

More detailed alternative

- Use change analysis during the investigation to help identify subtle differences between the conditions and events associated with the accident and those associated with other, problem-free operations. This can be particularly effective when the investigation team has trouble defining even the basic elements of the accident sequence (see Chapter 7, “Change Analysis”).

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	1 to 3 days	NA	Suggested approach + 2 to 4 hours
Large	~1 week	NA	

Investigation of a less serious, single accident or near miss requiring investigation

Marine safety investigators and other unit staff investigate many other accidents each year that are less serious or complex. Because of the number of minor accidents and other demands on the staff, these investigations must be handled quickly, yet effectively. These investigations are less thorough, but they must still identify important safety features that need improvement.

Suggested analysis approach

- Use the 5 Whys approach to structure the investigation and to identify the key causal factors contributing to the accident. This is a simple application of fault tree analysis (see the description of 5 Whys analysis in Chapter 11, "Fault Tree Analysis").
- Use a knowledge-based tool such as a root cause map to systematically explore the underlying root causes of each casual factor (see the description of the Root Cause Map in Chapter 4, "Checklist Analysis," and see the full version of the map that is included in your copy of the *Guidelines*).

Streamlined alternative

- For relatively straightforward accidents, the use of the Root Cause Map could be omitted as long as the 5 Whys analysis resolves the accident contributors to the root cause level

More detailed alternative

- Use change analysis during the investigation to help identify subtle differences between the conditions and events associated with the accident and those association with other, problem-free operations. This can be particularly effective when the investigation team has trouble defining even the basic elements of the accident sequence (see Chapter 7, "Change Analysis").

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	2 to 4 hours	1 to 2 hours	Suggested approach + 2 to 4 hours
Large	1 to 2 days	4 to 8 hours	

Investigation of a series of repeated, similar incidents (such as an increase in the number of a specific type of vessel deficiency over the past year)

Some types of incidents do not necessarily receive investigation each time they occur. Other incidents, as described above, receive only a quick investigation at each occurrence. Temporary or chronic trends in the number of these events sometimes draw attention from the COTP or other MTS stakeholders. In these cases, an investigation of these repeated, similar incidents can reveal systemic problems that offer risk reduction opportunities, even though not every incident is investigated in detail. Because a number of similar events are being pooled together, the unit can typically apply at least a moderate level of resources to such investigations. The results generally do not have to be highly precise, but they do need to be technically defensible.

Suggested analysis approach

- Use fault tree analysis during the investigation, as applied to investigation of chronic problems, to understand the dominant contributors to past incidents (see Chapter 11, "Fault Tree Analysis," as applied to investigations of chronic issues).
- Use a knowledge-based tool such as a root cause map to systematically explore the underlying root causes of each dominant contributor (see the description of the Root Cause Map in Chapter 4, "Checklist Analysis," and see the full version of the map that is included in your copy of the *Guidelines*).

Streamlined alternative

- A streamlined approach is not recommended

More detailed alternative

- A detailed Pareto analysis can be used in advance of the fault tree analysis to help identify specific types of incidents and to more narrowly focus the fault tree analysis on the dominant types of incidents (see Chapter 3, "Pareto Analysis").

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Small	1 to 3 days	NA	~1 day
Large	1 to 2 weeks	NA	1 to 3 days

3.0 Response-related Decisions

3.2 What actions should a unit take to minimize operational risks during response actions?

Example applications:

- Response to marine casualties
- Response to oil and HAZMAT spills
- ICS-based responses

Operational assets, such as MSO field inspectors and Group assets supporting "M" missions, encounter dynamic situations in which the following risk information is needed:

- An understanding of key risk factors affecting the operation
- An overall assessment of whether the risk associated with the operation is too high to continue
- An understanding of the factors and conditions to monitor as the operation continues, so that changing risk conditions are identified early

Individual operations occur at a fast tempo, and there is seldom time to perform formal, detailed risk assessments during operations. However, several factors can significantly increase loss exposure during operations, including the following:

- Complacency during operations
- Failure to account for differences between routine operations and more unique operations
- Changing conditions or situations such as weather, threats, crew fatigue, etc.

The crew or staff needs a simple tool to help it (1) keep aware of risk factors in its operations and (2) communicate risks among the crew. Of course, there may be time between operations to examine the risks of high-risk operations and seek ways to reduce the associated risks.

Suggested analysis approach

- Apply tactical operational risk management (ORM) concepts to help manage these operational risks (see COMDTINST 3500.3 on ORM for details)
- Use checklists as job aids to help refresh crew or staff awareness of key risk factors during these operations (see Chapter 4, "Checklist Analysis")

Streamlined alternatives

- None suggested

More detailed alternative

- Perform a Pareto analysis of past accidents and ensure that effective risk reduction actions have been taken to keep accidents from recurring (see Chapter 3, "Pareto Analysis")
- If concerns about a particular type of operation exist, or if there is simply a desire to reduce risk associated with these operations, perform a what-if analysis to (1) describe the risks of greatest concern to knowledgeable subject matter experts and (2) develop a list of risk reduction recommendations (see Chapter 8, "What-if Analysis")

Typical Time Required to Complete an Analysis

Scope of Analysis	Suggested Approach	Streamlined Approach	Detailed Approach
Tool creation	<1 day	NA	NA
Small	Minutes	NA	~1 day
Large	1 to 4 hours	NA	2 to 3 days